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B3F

(54) **Die casting**

(57) A die casting metal half mold (1) comprises a front wall (2) incorporating a die casting area, side walls (3) extending rearwardly from the front wall, a backing member (4) closing the base of said side walls, means (5) to fasten the backing member to the bottom of said side walls, the front wall, side walls and backing member forming a high pressure heat exchange cavity (7), a valve (8) for introducing fluid under pressure into said high pressure heat exchange cavity and a valve (9) for releasing gas under pressure from said high pressure heat exchange cavity. An ejector pin (13) may pass through a post (12) integral with the front wall. The wall thickness of the front wall may be increased in areas where the casting is thin to decrease the rate of heat removal. The heat-exchange medium may be pressurised water.

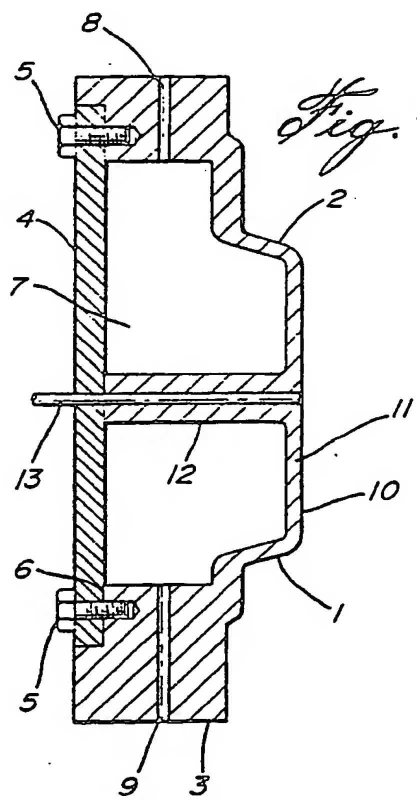

Fig. 1

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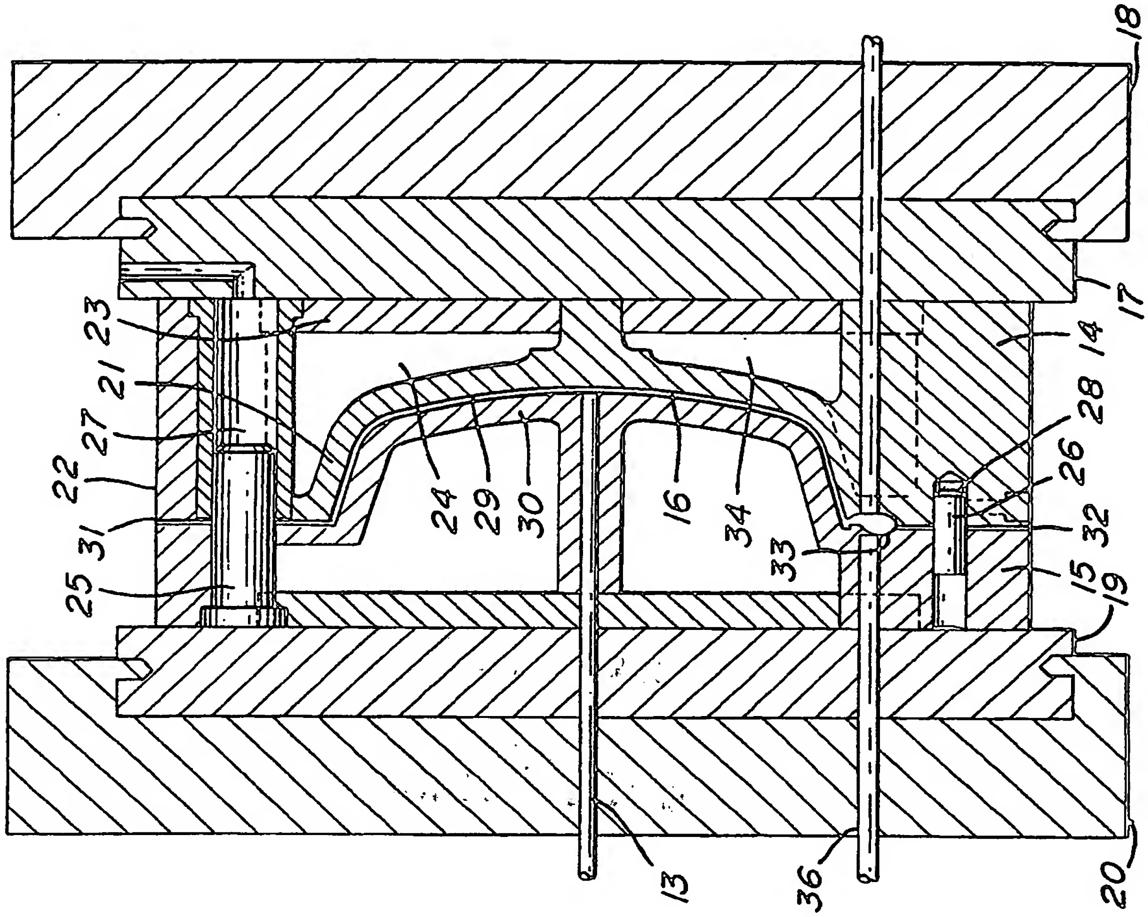

Fig. 2

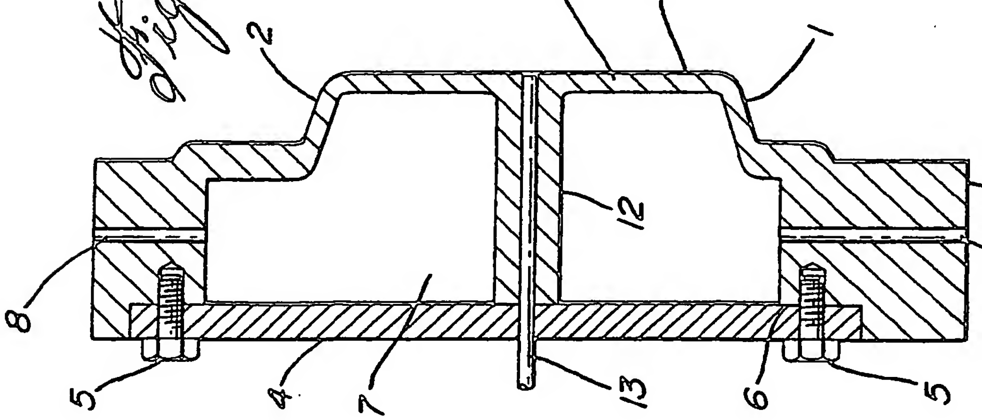

Fig. 1

SPECIFICATION

Die casting

This invention relates to die casting mold halves and die casting molds made of mold halves one or both of which has a high pressure heat exchange cavity.

Die casting molds currently in use utilize water at atmospheric pressure as the heat exchange medium to remove heat from the die cavity. Heat exchange is achieved by drilling a series of conduits through the die block which enables water to be circulated through the die block and thus cool the die cavity. As the systems in use to exchange the heat from the die cavity are not pressurised, sufficient cool water must be circulated through the die block to sufficiently cool the die cavity so that the cast metal may be shot into the die cavity, cooled, solidified and removed. The temperature of the hot metal introduced into the die cavity varies from metal to metal. Zinc is usually introduced into molds at about 425°C (800° Farenheit) while aluminium is introduced into molds at about 650°C (1200° Farenheit), while the temperature of the circulating water is normally between 21°C and 93°C (70° and 200° Farenheit). The resultant temperature differential between the hottest and coldest parts of a conventional mold when casting zinc and aluminium respectively is about 312°C and 538°C (600° and 1000° Farenheit).

The heat exchange conduits of conventional molds are normally spaced at least several inches away from the die casting cavity and several inches away from each other so that the steel between the heat exchange conduits and the die cavity will disseminate the cooling effect of the cold water flowing through the heat exchange conduits before the cooling effect reaches the die cavity. The greater the thickness of steel between the die casting cavity and the heat exchange conduits in conventional molds, the more even will be the temperature profile across the die casting cavity. On the other hand, the greater the thickness of steel between the heat exchange conduits and the die cavity the slower will heat exchange take place.

If the heat transfer conduits of conventional molds are placed close to the die cavity there is an increased possibility of thermal fatigue occurring in the mold because of the substantial temperature differential occurring over a narrow thickness. A further disadvantage of placing conventional heat transfer conduits in close proximity to the die cavity is the creation of temperature distortions caused by wide temperature differentials between those areas of the die cavity most proximate to the heat transfer conduits and those areas of the die cavity furthermost from the die casting.

Another difficulty with elongated tubular heat transfer conduits of conv ntional molds is that the continual passag of water through these conduits leads to the build up of slime or scaling on the sides of the walls of the conduit. This problem may be allieviated somewhat by conditioning or treating the cooling water prior to use. Scaling or slime reduces normal heat transfer between the water and the mold and causes uneven distribution of heat in the mold. The mold must be continually treated to remove slime or scale to maintain satisfactory h at transfer.

The pres nt invention accordingly provides a die casting half mold comprising a front wall incorporating a die casting area, side walls extending rearwardly from the front wall, a backing member closing the base of said side walls, means to fasten the backing member to the bottom said side walls, the front wall, side walls and backing member forming a high pressure heat exchange cavity, a valve for introducing fluid under pressure into said high pressure heat exchange cavity and a valve for releasing gas under pressure from said high pressure heat exchange cavity.

Preferably, the side walls and front wall are integral and are formed from a single metal block.

Pieces which are to be cast in die casting molds have an endless variety of shapes and thickness. The amount of hot metal to be cooled increases with the thickness of piece to be cast, decreases with the thinness of the piece to be cast and is directly related to the surface area of the piece to be cast. By utilising a high pressure heat exchange cavity and high temperature heat exchange medium, it is possible to conform the configuration of the main heat exchange wall in the high pressure heat exchange cavity to create a temperature profile on the die casting part of the mold substantially conforming to the heat to be removed from various parts of the piece being cast.

The thicker parts of the piece being cast must have more heat transferred therefrom while the thinner parts of the piece being cast require less heat to be removed therefrom. By substantially inversely profiling the thickness of the inside of the main heat exchange of the wall of the high pressure heat exchange cavity to conform to the heat to be removed from various parts of the die casting area, a cooling profile may be obtained which will remove more heat from those parts of the casting requiring more heat loss in solidifying and less heat will be removed from those parts of the casting requiring less heat loss to solidify.

Preferably therefore, the thickness of the front wall in the die casting varies so that it may be inversely proportional to the heat to be removed from the die part which is to be cast.

Preferably, the thickness of the front wall in the die casting area is between 8.4 mm and 12.7 mm (0.33 and 0.5 of an inch).

Preferably, the surface area of the front wall is substantially the same in the region of the die casting area both inside the cavity and on the moulding surface thereof.

Preferably, one or more posts extend through the pressure cavity to the front wall to support the front wall.

Preferably, one or more of said posts is hollow and incorporates an ejector pin extending through the pressure cavity.

Preferably, the posts are integral with the front wall.

The invention includes a die casting mould comprising first and s cond half molds adapt d to define

a mold cavity for receiving material to be molded, at least one of said half molds comprising wall members defining a pressure cavity, one of said wall members having a die casting area for participating in defining said mould cavity, and further comprising valve means for introducing fluid under pressure into said pressure cavity and valve means for releasing gas under pressure from said pressure cavity.

Preferably, each half mold comprises wall members defining a pressure cavity, one of said wall members having a die casting area for participating in defining said mould cavity, and further comprises valve means for introducing fluid under pressure into said pressure cavity and valve means for releasing gas under pressure from said pressure cavity.

The invention includes a method of die casting comprising introducing into the mold cavity of a mold as described above a molten material and cooling the molten material to solidity the same by maintaining in the pressure cavity a heat exchange liquid which is in part vaporised by heat extracted from the molten material, the vapour produced escaping through said valve means for releasing gas under pressure from said cavity.

Preferably, the thickness of the cavity wall in the die casting area is as thin as possible in relation to the pressure of the metal and the shape of the part to be cast.

Preferably, the heat exchange liquid is maintained at a pressure such that the boiling point of the heat exchange liquid in the cavity corresponds to the temperature at which the mold is to be maintained.

Preferably, the heat exchange liquid in the cavity is maintained at a pressure such that the boiling point of the heat exchange liquid is between 130° and 260°C (270° and 500° Farenheit).

The invention will be illustrated by the following description of a preferred embodiment thereof with reference to the accompanying drawings wherein:

Figure 1 is a cross-sectional view through half of a permanent mold, constituting a half mold according to the invention;

Figure 2 is a cross-sectional view through the permanent mold of Figure 1 including means for retaining the mold halves in line.

Referring to Figure 1, there is shown a mold half (1) comprised of a front wall (2), side walls (3) and a backing member (4). The backing member (4) is fastened to the bottom of the side walls (3) by bolts (5). A thin high pressure gasket (6) capable of withstanding high temperatures and high pressures is placed between the bottom of side walls (3) and backing member (4) before the bolts (5) are securely fastened. A high pressure heat exchange cavity (7) is formed between the front wall (2), side walls (3) and the backing member (4). An inlet valve (8) is provid d in the side wall (3) to add fluid to the high pressur heat exchange cavity (7) wh n required. An outlet valve (9) is provid d in side wall (3) to remove gas from the high pressure heat exchange cavity (7) after each casting sequence. The front wall (2) includes a die casting area (10) which receives the hot casting liquid. The central part of die casting area (10) forms part of the di cavity in which the cast article is formed. Th shape of front wall (2) and die casting area (10) will vary from mold to mold reflecting the shape of the article being cast. The thin wall (11) between the die casting area (10) and the high pressure heat exchange cavity (7) may be as thin as 8mm (0.3 inches) in thickness depending upon the size and configuration of the part being cast and correspondingly the heat to be removed from any part of the die casting area (10). In the mold half (1), shown in Figure 1, a column (12) is formed through the high pressure heat exchange cavity (7) to provide additional support to the front wall (2). An ejector pin (13) runs through the column (12).

Referring to Figure 2, there are shown two mold halves (14, 15) in closed position forming die cavity (16). Mold half (14) is fastened to a block (17) which is fastened to one of the platens (18) of the die casting machine which will move mold half (14) towards, closed on or away from mold half (15). Similarly mold half (15) is fastened to block (19) which is fastened to the other platen (20) of the die casting machine which will move mold half (15) towards, closed on or away from mold half (14). Mold half (14) is comprised of front wall (21), side walls (22) and backing member (23). High pressure heat exchange cavity (24) is formed between front wall (21), side walls (22) and backing member (23). Mold half (15) includes two or more guidepins (25) and (26) which are retained within bushings (27) and (28) respectively to maintain mold halves (14, 15) aligned. When mold halves (14, 15) are closed as shown in Figure 2, the die cavity (16) is formed between die cavity areas (29, 30) of mold halves (14, 15) respectively.

With the mold halves (14, 15) in closed position, hot casting metal is introduced at gate (31) and air is vented at vent (32) until die cavity (16) and overflow (33) are filled with hot casting fluid. The hot casting metal is introduced at pressure of up to 13,790 KPa (2000 p.s.i.) and 425°C (800° Farenheit) for zinc and up to 34, 475 KPa (5000 p.s.i.) and 650°C (1200° Farenheit) for aluminium. When casting with zinc the high pressure heat exchange cavity (24) contains heat exchange fluid (34) under pressure having a temperature up to 230°C (450° Farenheit). The same is true of mold half (14).

With a temperature differential of about 205°C (400° Farenheit) when zinc is being cast in die cavity (16) and the heat exchange fluid (34) in high pressure heat exchange cavity (24), heat will flow through die cavity area (29) to the heat exchange fluid (34) causing a small portion of the heat exchange fluid to vaporize. The vapor will be bled to the atmosphere through a pressure control valve as indicated in Figure 1.

When the casting is solidified the mold halves (14) and (15) are moved apart by the platens (18, 20), the casting is ejected from the die casting cavity by ejecting rods such as (13, 36) and similar rods not indicated in the drawing.

An additional advantag of high pressure heat exchange cavity (24), is that prior to start up of the casting operation, the heat exchange fluid (34) can be heated under pressure and the temperature of

eacn of the half molds can be raised to 230°C (450° Farenheit) or any other desired temperature before the casting is started. The temperature of the mold can be controlled by a combination of a pressure controls on inlet valve (8) and outlet valve (9) of high pressure heat exchange cavity (7) in combination with an immersion heater in high pressure heat exchange cavity (7).

It is an advantage of the mold described in detail above that it has a thin wall between the die casting area of the half mold and the high pressure heat exchange cavity. The thin wall between the die casting area and the high pressure heat exchange cavity covers substantially the whole surface area between the die casting area and the high pressure heat exchange cavity.

A high pressure heat exchange cavity enables the heat exchange medium in the high pressure heat exchange cavity to be maintained as a liquid at a high temperature relative to the temperature at which the metal being cast in the mold is introduced in the mold. A die casting half mold having a thin wall of large surface area between the die casting area of the half mold and the high pressure heat exchange cavity was created to take advantage of the relatively lower temperature differential between the metal being cast and the heat exchange medium for removing the heat obtained by utilizing a relatively high temperature heat exchange medium.

With a die casting mold having a pressurised heat exchange cavity, it is possible to raise the temperature of the heat exchange medium to any desired temperature up to 230°C (450° Farenheit). The temperature differential between the die cavity and the high pressure heat exchange cavity across the die casting area of the front wall is substantially less than that found with molds cooled by water running through conduits in the mold. The lower temperature differential has resulted in the manufacture of a mold having a die cast wall with a thickness as thin as 8 mm (three-tenths of an inch) depending on the dimension of the casting and the heatr to be removed therefrom. The die casting area generally includes all that part of the front wall which receives the hot casting material.

The lower heat differential between the die cavity and the high pressure heat exchange cavity has also made it possible to increase the surface area of the high pressure heat exchange cavity in contact with the die cast area of the front wall. The surface area of the thin wall is the die casting area of the front wall receiving hot liquid.

With the increased surface area of the high pressure heat exchange cavity in contact with the die casting area of the mold, it is possible to obtain both a larger heat exchange surface and an improved temperature profile on the die casting area of the mold.

A further advantage of the illustrated embodiment is that with a pressurised heat exchange medium such as for instanc , water, only sufficient water needs to be added to the heat exchange cavity to replace the steam driven off by the heat exchange occurring as a result of each shot of metal into the die cavity. As a result, sliming or scaling does not occur and the aobve problem does not exist within the pressurised heat exchange cavity.

While the invention has been shown and described in one embodiment, it will be clear to thos skilled in the art that the precise details of construction will vary from article to article which is to be cast. The invention is not confined to the precise details of construction which are shown in the drawings but includes those changes and variations which must necessarily be made by those skilled in the art in preparing permanent metal molds incorporating the teachings of this invention, without departing from the spirit of the Invention, or exceeding the scope of claims.

CLAIMS

1. A die casting half mold comprising a front wall incorporating a die casting area, side walls extending rearwardly from the front wall, a backing member closing the base of said side walls, means to fasten the backing member to the bottom of said side walls, the front wall, side walls and backing member forming a high pressure heat exchange cavity, a valve for introducing fluid under pressure into said high pressure heat exchange cavity and a valve for releasing gas under pressure from said high pressure heat exchange cavity.

2. A half mold as claimed in claim 1 wherein the side walls and front wall are integral and are formed from a single metal block.

3. A half mold as claimed in claim 1 or claim 2 in which the thickness of the front wall in the die casting varies so that it may be inversely proportional to the heat to be removed from the die part which is to be cast.

4. A half mold as claimed in any one of claims 1 to 3 in which the thickness of the front wall in the die casting area is between 8.4 mm and 12.7 mm (0.33 and 0.5 of an inch).

5. A half mold as claimed in any preceding claim in which the surface area of the front wall is substantially the same in the region of the die casting area both inside the cavity and on the moulding surface thereof.

6. A half mold as claimed in any preceding claim in which the backing member is fastened securely to the side walls by a series of bolts with a gasket in between the backing member and the side walls.

7. A half mold as claimed in any preceding claim in which one or more posts extend through the pressure cavity to the front wall to support the front wall.

8. A half mold as claimed in claim 7 in which one or more of said posts is hollow and incorporates an ejector pin extending through the pressure cavity.

9. A half mold as claimed in claim 7 or claim 8 in which the posts are integral with the front wall.

10. A die casting metal half mold substantially as hereinbefore described with reference to and as illustrated in the accompanying drawing.

11. A die casting mould comprising first and second half molds adapted to define a mold cavity for receiving mat rial to be molded, at l ast one of said half molds comprising wall members defining a

pressure cavity, one of said wall members having a die casting area for participating in d fining said mould cavity, and further comprising valve means for introducing fluid under pressure into said pressure cavity and valve means for releasing gas under pressure from said pressure cavity.

12. A die casting mold as claimed in claim 11 wherein each half mold comprises wall members defining a pressure cavity, one of said wall members having a die casting area for participating in defining said mold cavity, and further comprises valve means for introdicing fluid under pressure into said pressure cavity and valve means for releasing gas under pressure from said pressure cavity.

13. A die casting mold as claimed in claim 11 or claim 12 wherein one or both half molds is as defined in any one of claims 1 to 9.

14. A die casting mold as claimed in any one of claims 11 to 13 in which the thickness of cavity wall in the die casting area is inversely proportional to the heat to be removed from the die part which is to be cast in the mold cavity to obtain uniform cooling thereof.

15. A die casting mold substantially as hereinbefore described with reference to and as illustrated in the accompanying drawing.

16. A method of die casting comprising introducing into the mold cavity of a mold as claimed in any one of claims 11 to 15 a molten material and cooling the molten material to solidity the same by maintaining in the pressure cavity a heat exchange liquid which is in part vaporised by heat extracted from the molten material, the vapour produced escaping through said valve means for releasing gas under pressure from said cavity.

17. A method as claimed in claim 16 in which the thickness of the cavity wall in the die casting area is as thin as possible in relation to the pressure of the metal and the shape of the part to be cast.

18. A method as claimed in claim 16 or claim 17 in which the heat exchange liquid is maintained at a pressure such that the boiling point of the heat exchange liquid in the cavity corresponds to the temperature at which the mold is to be maintained.

19. A method as claimed in any one of claims 16 to 18 in which the heat exchange liquid in the cavity is maintained at a pressure such that the boiling point of the heat exchange liquid is between 130° and 260°C (270° and 500° Farenheit).

20. A method of die casting substantially as hereinbefore described with reference to the accompanying drawing.

21. A die casting half mold comprising wall members defining a pressure cavity, one of said wall members having a die casting area for participating in defining a mold cavity, and valve means for introducing fluid under pressure into said pressure cavity and valve means for releasing gas under pressure from said pressure cavity.

22. A die casting metal half mold comprising a front wall incorporating a die casting area, side walls extending rearwardly from the front wall, a backing member closing the base of said side walls, means to fasten the backing member to the bottom of said side walls, the front wall, side walls and backing member forming a high pressure heat exchange cavity, a valve for introducing fluid under pressure into said high pressure heat exchange cavity and a valve for releasing gas under pressur from said high pressure heat exchange cavity.

23. The die casting metal half mold of claim 22 in which the front wall in the die casting area is thin, and the bottom of the die casting area of the front wall forms the top of the high pressure heat exchange cavity.

24. The die casting metal half mold of claim 22 in which the thickness of the front wall in the die casting area is inversely proportional to the heat to be removed from the die part which is to be cast.

25. The die casting metal mold half of claim 22 or 23 in which the thickness of the front wall of the die casting area is as thin as possible in relation to the pressure of the metal and the shape of the part to be cast.

26. The die casting metal mold half of claim 22 or 23 including a heat exchange medium in which the pressure in the high pressure heat exchange cavity is maintained at a point such that the boiling point of the heat exchange medium corresponds to the temperature at which the mold is to be maintained.

27. The die casting metal mold half of claim 22 or 23 including a heat exchange medium in which the pressure in the high pressure heat exchange cavity is maintained at a point such that the boiling point of the heat exchange medium is between 130° and 260°C (270° and 500° Farenheit).

28. A die casting metal half mold comprising a front wall incorporating a die casting area, integral side walls extending rearwardly from the front wall, said front wall and integral side walls being formed from one block of metals, a backing member for closing the base of said walls, means to securely fasten the backing member to the bottom of said side walls, the front wall, side walls and backing member forming a high pressure heat exchange cavity, an inlet valve for introducing fluid at high temperature under pressure into said pressure enclosure, and an outlet valve for releasing gas under pressure from said pressure enclosure.

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